Brought to you by https://KalExamHai.GitHub.io

SHRI MATA VAISHNO DEVI UNIVERSITY, KATRA

Minor (Odd Semester) – 2019-20

B.Tech. || ME || Sem III

Thermodynamics

Subject Code: MEL-1211

Time allowed: 1.5 Hrs **Max Marks: 30**

1 A reversible heat engine absorbs 2500 kJ/cycle of heat from a constant temperature heat source at 2000 K and rejects some energy as waste heat to a reservoir X. The work output from the engine is used to drive a reversible refrigerator; its source temperature being 300 K. The heat outflow from the refrigerator is also taken to reservoir X. If the total heat flow into the reservoir is 3000 kJ/cycle, make the calculations for temperature of reservoir X. (5)

2 State the limitations of first law of thermodynamics (2)

3 A centrifugal pump delivers 2750 kg of water per minute from initial pressure of 0.8 bar absolute to a final pressure of 2.8 bar absolute. The suction is 2 m below and the delivery is 5 m above the center of pump. If the suction and delivery pipes are of 15 cm and 10 cm diameter respectively, make the calculations for the power required to run the pump (5)

4 Three Carnot engines E1,E2 and E3 operate between temperatures of 1000 K and 300 K Make calculations for the intermediate temperatures if the work produced by the engines are in the ratio of 4:3:2. (5)

5 One kg of air at 1 bar and 300 K is compressed adiabatically till its pressure becomes 5 times the original pressure. Subsequently it is expanded at constant pressure and finally cooled at constant volume to return to its original state. Calculate the heat and work interactions, and change in internal energy for each process and for the cycle. (5)

6 Develop the following expression (3)

$$Q_{1-2} = \frac{\gamma - n}{\gamma - 1} X \text{ polyropic work done}$$

7 Explain the concept of clausius inequality for reversible and irreversible heat engines (5)

Brought to you by https://KalExamHai.GitHub.io

SHRI MATA VAISHNO DEVI UNIVERSITY, KATRA
School of Mechanical Engineering
B. Tech. Major Examination (Odd) 2019-20

Entry No: 1 8 B M E 0 2 9

Total Number of Pages: [1]
Total Number of Questions: [10]

Course Title: Thermodynamics
Course Code: MEL-1211

Time Allowed: 3 Hours **Max Marks: [50]**

Instructions

i. **Attempt All Questions.**
ii. **Support your answer with neat freehand sketches/diagrams, wherever appropriate.**
iii. **Assume any missing data to suit the case / derivation / answer.**

1. 0.2 m^3 of an ideal gas at a pressure of 2 MPa and 600 K is expanded isothermally to 5 times the initial volume. It is then cooled to 360 K at constant volume and then compressed back polytropically to its initial state. Determine the net work done and heat transfer during the cycle. (5)
2. A steam turbine operates under steady flow conditions receiving steam at the following state: pressure 15 bar; internal energy 2700 kJ/kg; specific volume 0.17 m^3/kg and velocity 100 m/s. The exhaust of steam from the turbine is at 0.1 bar with internal energy 2175 kJ/kg, specific volume 15 m^3/kg and velocity 300 m/s. The intake is 3 meters above the exhaust. The turbine develops 35 kW and heat loss over the surface of turbine is 20 kJ/kg. Determine the steam flow rate through the turbine. (5)
3. A reversible heat pump is required to maintain a temperature of 0°C in a refrigerator while rejecting heat to the surroundings at 300 K. If the heat removed rate from the refrigerator is 25 kW, determine the COP of the machine and work input required. Proceed to determine the overall COP of the system if the power required to run the machine is developed by a reversible engine which operates between higher and lower temperature limits of 650 K and 300 K respectively. (5)
4. 3 kg of air at 150 kPa pressure and 360 K temperature is compressed polytropically to pressure 750 kPa according to the law $PV^{1.2}$=constant. Subsequently, the air is cooled to the initial temperature at constant pressure. This is followed by expansion at constant temperature till the original pressure of 150 kPa is reached. Sketch the cycle on P-V and T-S plots and determine the work done, heat transfer and entropy change for each process. (5)
5. A steam turbine working on the Rankine cycle is supplied with dry saturated steam at 25 bar and the exhaust takes place at 0.2 bar. For a steam flow rate of 10 kg/s, determine: (a) quality of steam at end of the expansion (b) turbine shaft work (c) power required to drive the pump (d) work ratio (e) Rankine efficiency (f) heat flow in the condenser. (5)
6. Derive an expression for available energy of a Non-flow or Closed system (5)
7. Show that the work done per kg of a perfect gas during an adiabatic expansion for which PV^{γ}=constant is given by: $W_{1-2} = \frac{R(T_1 - T_2)}{\gamma - 1}$ (5)
8. Sate and prove the Carnot theorem and its corollaries (7)

P.T.O

Brought to you by https://KalExamHai.GitHub.io

9. Determine the amount of heat required to generate 5 kg of steam at a pressure of 10 bar and temperature of 250 °C from water at 25 °C. Take specific heat for superheated steam as 2.1 kJ/kg K. (3)

10. Derive an expression for a steady flow energy equation and point out the significance of various terms involved. (5)